UNCERTAINTY REGARDING INCOME REPLACEMENT IN MONEY PURCHASE PENSION PLANS: EVIDENCE AND INTERPRETATION

Prepared by : James E. Pesando
October, 1981

October, 1981

UNCERTAINTY REGARDING INCOME REPLACEMENT IN MONEY PURCHASE PENSION PLANS: EVIDENCE AND INTERPRETATION

by

James E. Pesando*

DEPARTMENT OF CONSUMER & CORPORATE AFFAIRS
LIBRARY
AUG 15 1984
BIBLIOTHÈQUE
MINISTÈRE DE LA CONSOMMATION ET DES CORPORATIONS

* Professor of Economics and Research Associate, Institute for Policy Analysis, University of Toronto.

"The views presented in this paper are those of the author and do not necessarily reflect the views of or positions of the Department of CCAC
Les points de vues exprimés dans cette étude sont ceux de l'auteur et il ne reflètent pas nécessairement la position du Ministère."

EXECUTIVE SUMMARY

The purpose of this study is to examine the income replacement capabilities of money purchase pension plans. The term "money purchase" refers to pension plans for which a retired employee's pension income is based explicitly and exclusively on the accummulated contributions which have accrued in his name. At present, most members of occupational pension plans are in defined benefit plans. The term "defined benefit" relates to pension plans in which the pension, for which an employee is eligible, is based upon his prior income level (when employed) and number of years of service. Many aspects of defined benefit plans have been subject to strong criticism. In particular the solvency, vesting, portability, survivor benefit, and inflation protection provisions of defined benefit plans have been deemed unsatisfactory. This situation has led to demands from various groups for greatly expanded public (i.e. tax-financed) pension plans. While there have been widespread ad hoc improvements to defined benefit plans, money purchase pension plans represent an alternative approach which appears capable of remedying many of these well known shortcomings. In fact, the Royal Commission on the Status of Pensions in Ontario recommended implementation of a money purchase type plan, the Provincial Universal Retirement System (PURS). Moreover, Manitoba is instituting a voluntary employer pension plan (VEPP) of the money purchase type. RRSPs, which are assuming an increasingly important role in Canada's retirement income system, represent a type of money purchase plan.

Under money purchase pension plans in particular, the 'income replacement rate' (i.e. pension income as a proportion of employed income) depends importantly upon the level of contributions, the rate of interest earned upon those accumulated savings, and the length of the time period during which contributions are accumulated. These are the aspects of the pension issue which are explored in this study. These considerations are equally relevant for defined benefit plans. If the pension benefits for which a defined benefit plan is liable exceed funding, the pension plan is insolvent. Previous studies by this author have shown that the interest rate assumptions, which typically underlie defined benefit plans, are highly questionable.

This report estimates the income replacement rates obtainable by contributions held in various investment portfolios, for varying time periods, and for different career earnings profiles. The analysis investigates the income replacement rates where pension contributions are specified as a proportion of employee income. The results of simulations, based on historical data, suggest that the replacement income rate is highly sensitive to the form in which contributions are accumulated. Even for a specific financial asset the actual

replacement rate is quite uncertain. This is particularly the case if contributions are held in the form of common stocks. These findings reflect primarily differences in the real rate of return, and the volatility thereof, corresponding to the alternative assets which may constitute the pension investment portfolio. In addition, the results illustrate the sensitivity of income replacement rate to the career earnings profile and the length of the contribution period.

CONTENTS

I Introduction: the issues

II Historical Data on the Real Returns to Alternative Assets

III The Simulation Experiments: Design

IV The Simulation Exercises: Results

V Money Purchase versus Defined Benefit Plans and the Role for Public Policy

1. The Exposure of Members of Defined Benefit Plans to Inflation Risk

2. The Transfer of Investment Risk to Employers/Shareholders in Defined Benefit Plans and the Role of Compensating Wage Differentials

3. Ad Hoc Cost-of-Living Adjustments Financed from "Excess" Investment Earnings: Are Defined Benefit Plans just Money Purchase Plans in Disguise?

VI Implications for Public Policy

I Introduction: the issues

At present, the vast majority of members of occupational pension plans in Canada are in defined benefit plans. In 1978, 93.6 percent of plan members were in defined benefit plans, while only 4.8 percent were in money purchase or defined contribution plans (Statistics Canada (1980)).[1] Further, the majority of members of money purchase plans were in small plans, as is evident from the fact that 43.2 percent of occupational pension plans in 1978 were money purchase plans. Money purchase plans are thus concentrated among small firms, where either administrative costs or the probability of firm insolvency mitigate against the use of a defined benefit formula. In short, firms and their employees would appear to have a preference for the defined benefit formula, which may be regarded - at least tentatively - as the market solution to the problem of optimal pension arrangements.

In spite of this fact, many now advocate an expanded role for money purchase plans within the occupational pension system. The centrepiece of the recommendations put forward by the Royal Commission on the Status of Pensions in Ontario is a universal money purchase plan, the Provincial Universal Retirement System (PURS). Both the employer and the employee would make predetermined contributions to PURS on behalf of the employee. The employee would determine how the accumulated funds are invested, just as he would with an RRSP. Manitoba has recently proposed the introduction of a (more modest) voluntary employer pension plan (VEPP), which would also be of the money purchase variety. Further, most proposals for the reform

---

[1] The remaining 1.6 percent of plan members were in profit sharing or composite plans.

of the private pension system call for the expanded use of "locked-in" RRSPs as a means of improving the effective portability of pension benefits.

Those who advocate an expanded role for money purchase plans draw attention to a now standard list of the "limitations" of defined benefit plans. Benefit accruals are quite small for young employees, the plans may be underfunded and the security of the promised benefits may occasionally be placed in jeopardy, the portability of pension credits or years of pensionable service is difficult to achieve, only final earnings plans preserve - on a contractual basis - the real value of benefits as they accrue during the member's active work years, and all defined benefit plans - in the absence of some form of contractual cost-of-living adjustments - expose the pensions ultimately provided to erosion by inflation during the member's retirement years. By contrast, money purchase plans are age neutral, fully funded by definition, vest immediately, are fully portable, and - because nominal interest rates compensate the investor for anticipated inflation - preserve the real value of the member's benefit from anticipated inflation during both his active work and his retirement years.

Those who advocate an expanded role for money purchase plans may be discomforted by the apparent preference of workers for defined benefit plans. To some, the simple response is that defined benefit plans are not well suited to today's inflationary environment. More substantively, as evident by the willingness of most large employers to grant ad hoc cost-of-living adjustments to pensions in pay,[2] the distinction between defined benefit and money purchase plans may have become blurred. To the extent

---

[2] See, for example, the data summarized by the Task Force (1980), especially on pages 49-50 of Volume One.

that firms use "excess" investment earnings (i.e., investment earnings above the assumed valuation rate) to enrich either pensions in pay or the nominal benefit formula (for example, in career average plans), the plan member - as distinct from the shareholder - has the proprietary interest in the performance of the pension fund. To some extent, there has been a metamorphosis of the defined benefit plan into a defined benefit/ money purchase hybrid.

In spite of the above observation, which has important implications, most advocates of the expanded use of money purchase plans do not emphasize the fact that the plan member bears all of the investment risk under this type of plan design. The Royal Commission - for example - does not address the problem of investment risk,[3] and the supporting research studies simply avoid the problem by assuming a constant real interest rate in the simulation exercises.[4] In general, uncertainty regarding the fraction of pre-retirement income that would be replaced under a money purchase plan with a fixed contribution rate is a neglected aspect of the policy debate regarding the provision of retirement incomes. The fact that the plan member assumed all of the investment risk has caused at least some observers to summarily dismiss the recommendation that money purchase plans be encouraged as a matter of public policy. The fact that "like employees with like contributions" might have substantially different pensions, depending upon

---

[3] On page 263 (Volume II), the Royal Commission refers to the "single disadvantage" of money purchase plans, which is the inability to provide past service credits. As a result, these plans take considerable time to mature and thus to begin to deliver significant retirement incomes.

[4] Y. Balcer and I. Shain, "A Study of Private Pensions in Ontario", (Volume VIII) use assumed real returns of 2.4, 2.6 and 2.4 percent in the periods 1980-84, 1985-89, and 1990 and beyond in their simulation exercises. No allowance is made for the uncertainty of these real returns.

their fund's performance, is frequently cited as an additional reason why money purchase plans are not to be encouraged.

The purpose of this paper is twofold. First, through stochastic simulation, the paper seeks to establish the degree of uncertainty regarding the income replacement rates in a money purchase plan with a fixed contribution rate. These exercises highlight the characteristics of the risk-return tradeoffs for alternative investment portfolios, and are of independent interest in view (for example) of the expanding role of RRSPs in Canada's retirement income system.[5] Second, the paper seeks to interpret these results in light of (1) the risks to which members of defined benefit plans are exposed, (2) the role of compensating wage differentials when employers/shareholders do assume investment risk in defined benefit plans, and (3) the apparent metamorphosis of defined benefit plans into defined benefit/money purchase hybrids. Both objectives are designed to shed light on the ultimate issue of whether money purchase plans ought to be encouraged as a matter of public policy.

II Historical Data on the Real Returns to Alternative Assets

Annual data on the real returns to 91-day Treasury Bills, long-term Government of Canada bonds, common stocks, provincial bonds, corporate bonds and conventional mortgages for the period 1953-1980 are presented in Table 1. The means, standard deviations and correlation coefficients are also presented, as is the annual rate of inflation as measured by the consumer price index. Because these data and their interpretation are of

[5] By 1976, the latest year for which detailed data are available, 10.5 percent of the over 12 million persons who filed income tax returns reported RRSP contributions.

interest independent of their role in the simulation exercises, their central characteristics are reviewed briefly below.

Note first that the sample period was chosen to avoid periods of deflation, which occurred last in Canada in 1952. Because nominal interest rates are bounded below by zero (and must generally exceed zero in the presence of positive transactions costs), the ability of nominal interest rates to embody an appropriate inflation premium is not symmetric with respect to periods of anticipated inflation and anticipated deflation. To include periods of deflation in the calculation of descriptive statistics such as the mean and standard deviation of (say) Treasury Bills is potentially quite misleading.[6]

Note that the real returns on all the alternative assets are negatively correlated with inflation, at least in the 1953-1980 period. This result mirrors the concern that traditional pension plan assets may not provide an adequate hedge against inflation. Stocks have the smallest (in absolute value) correlation with inflation, yet their high standard deviation indicates their inherent degree of business risk. The minimum variance portfolio, in the absence of short selling, is a portfolio invested entirely in Treasury Bills, which would yield an expected real return of somewhat less than one percent. There is no attempt to isolate the impact of anticipated as distinct from unanticipated inflation on real returns. The data as presented presume that the market prices the alternative assets to yield equilibrium ex ante real returns, and that unanticipated inflation is simply one of a myriad of sources of new information which

---

[6] In 1931, for example, prices as measured by the consumer price index fell by 10.21 percent and the real return on Treasury Bills was 12.91 percent. (See Table 1 for source.) The result of including this particular year of deflation would be to significantly increase both the estimated mean and standard deviation of the real return on Treasury Bills.

can cause realized to depart from ex ante returns. For fixed-income securities, especially if unanticipated inflation conveys information regarding the permanent or long-run rate of inflation, this particular source of new information is - of course - likely to be of paramount importance.

Note that the realized real returns on long-term Canada, provincial and corporate bonds are depressed - and, in two cases, negative - during the 1953-1980 period. This result is not surprising in view of (1) the (almost) secular increase in the rate of inflation, which suggests that a significant amount of the observed inflation was unanticipated and (2) the depressing impact on the real returns on long-term, fixed-income securities of unanticipated, permanent inflation. For purposes of simulation, these depressed real returns are clearly unrealistic. As noted in footnotes to Table 2, real returns of 2.0, 2.75 and 3.0 percent are used for the Canada, the provincial and the corporate bonds, respectively. Data on standard deviations and correlation coefficients remain fixed at their historical values.

The stochastic simulations depend crucially on the assumed means, standard deviations and correlation coefficients of the assets which comprise the alternative pension plan portfolios. The use of historical data (subject to the caveat above) to provide these inputs is the only practical alternative. If (say) the risk premium accorded common stocks has increased, as some observers maintain,[7] the real return employed in these simulations will be too low. To build this type of adjustment into the simulation exercise, although not difficult, would be entirely speculative.

---

[7] See, for example, B. Malkiel, "The Case for Common Stocks in the 1980s" in Sanderson (1980). He argues that increased uncertainty has caused the risk premium accorded common stocks to increase, a result which also helps explain the deterioration in price-earnings ratios throughout the 1970s.

On balance, there is no reason to believe that the use of the historical data will not be adequate for the purpose at hand.

III The Simulation Experiments: Design

The simulation experiments assume that a fixed percentage (the contribution rate) of the employee's salary during each year of his active work life is contributed to a money purchase plan. At age 65, the employee retires and uses the accumulated funds in the plan to purchase a life annuity. For simplicity, the employee is assumed to live with certainty for 16 years after he retires. He is able to purchase an annuity at an interest rate of 2.5 percent. This rate, which approximates the real return on a conservatively managed portfolio of fixed-income securities, is designed to ensure that the calculated replacement rates are <u>real</u> replacement rates (i.e., the ratio of a real or constant dollar pension benefit to pre-retirement earnings). The implications of using a higher nominal rate to value the annuity are discussed in the text. The contribution rate is fixed at 3.5 percent of salary. This is the rate (approximately) suggested by the Royal Commission on the Status of Pensions in Ontario for PURS.[8] As noted in the footnotes to Table 2, the adjustment to the indicated replacement rates for an alternative contribution rate is strictly proportional.

The simulation exercise begins with the choice of a particular investment strategy. If the decision is made (say) to hold only common stocks, then the mean and standard deviation of common stocks are specified. On

---

[8] Specifically, the Royal Commission proposed that employers contribute two percent of Salary (between the YBE and the YMPE established for the CPP), while workers contribute one percent while aged 18 to 30, 1.5 percent while aged 31 to 45, and two percent while aged 46 to 65. The target replacement rate for PURS would be "about" 20 percent of pre-retirement earnings. This target rate is not comparable to the rates presented in the tables in this report because the Royal Commission appears to have used an interest rate in excess of 6.4 percent in its annuity calculations. As a result, the income replaced under their assumptions is (implicitly) a cross between a real and a nominal rate.

the assumptions that the returns are (1) normally distributed and (2) serially uncorrelated, the return on the portfolio in any period is obtained by drawing at random from a normal distribution whose mean and variance are those assumed to characterize the distribution of real returns on common stocks. The experiments proceeds as follows. At the beginning of the first year, the member contributes (or has contributed on his behalf) 3.5 percent of his initial salary to a money purchase plan. If he decides to hold only common stocks, the return that the fund earns is generated by the procedure described above. At the beginning of the second year, he contributes 3.5 percent of his <u>then</u> current salary to the plan. This contribution, when added to the value of the plan's assets at the beginning of the second year, constitutes the fund which earns the real return in year two. This real return is determined by a second drawing from the assumed normal distribution. The process is then repeated for each year that the employee works. Since both the returns to the plan's assets and the (assumed) salary path are specified in real terms, the rate of inflation appears nowhere in the analysis. As discussed later, the rate of inflation is resurrected only if a nominal interest rate is used in the annuity calculation, which has the effect of transforming the pension from a real to a nominal benefit.

The assumption that the real returns to each asset are both normally distributed and serially uncorrelated merits further comment. The three key assets in the simulation exercises are Treasury Bills, common stocks and long-term bonds. Tests for the normality of the returns on the Treasury Bills, common stocks and the Government of Canada bonds indicated - in each case - that the null hypothesis of a normal distribution could <u>not</u> be

rejected.[9] The real returns on Treasury Bills, unlike those on common stocks and the Canada bonds, exhibited significant (positive) serial correlation.[10] This latter point merits additional comment.

As noted, the minimum variance portfolio (in the absence of short selling) is a portfolio invested exclusively in bills. For simplicity, the assumption of serial independence of the return on bills is retained in the main body of the simulation exercises. It must be noted, however, that the serial correlation which in fact exists in the bill returns will cause these exercises to <u>understate</u> the variance of terminal wealth in a bills only portfolio - and thus in the calculated replacement rates.[11] For

---

[9] The studentized range equalled 4.30, 3.98 and 4.25 for the stocks, bonds and bills, respectively. The 10 percent significance level for the sample size reported here is 4.70, so that the null hypothesis of normality could not be rejected. See Fama (1976), especially chapter one, for a discussion of the studentize range in the present context.

[10] For Treasury Bills, the real return (x_t) is estimated to behave as follows:

$$x_t = \underset{(1.17)}{.004680} + \underset{(2.17)}{.3968}\, x_{t-1}$$

The bracketed figures are t-statistics and the standard error of the regression is 0.01921.

[11] To see the point, consider the following (simplified) example. Suppose that the real rate of return on the first asset is described by (1) $\ln (1+r_t) \equiv x_t = x_{t-1} + e_t$ where e_t is serially uncorrelated and normally distributed, with expectation zero and variance σ_e^2. The (lognormal) return thus follows a random walk and has a serial correlation parameter equal to one. Let the real rate of return on the second asset be described by (2) $\ln (1+r_t) \equiv z_t = k + u_t$ where u_t has properties analogous to e_t. Let W_N be the terminal wealth resulting from buying one dollar of the asset at the beginning of the first year and reinvesting the proceeds for N years. Even if σ_u^2 is much greater than σ_e^2, so that the one-period variance of the return on the second asset greatly exceeds that on the first, the variance of $\ln W_n$ will - for large enough N - be greater for the first asset. As the variance of $\ln W_n$ increases, so does the variance of the replacement rates in the simulation exercises described in the text. Although, unlike the first asset, real bill returns do not follow a random walk, they do have substantial serial correlation which produces an analogous effect.

this reason, an additional simulation which incorporates the serial correlation in bill returns is reported in the discussion.

IV The Simulation Experiments: Results

Consider first the results presented in Table 2. The worker makes contributions equal to 2.5 percent of salary from age 20 to 64 (i.e. for 45 years), and his salary grows at 2 percent per year. The median replacement rate (i.e. the ratio of the pension to pre-retirement earnings) and related summary statistics for 25 stochastic simulations are presented for four alternative portfolios: common stocks, Treasury Bills, a portfolio approximating the aggregate portfolio of trusted pension plans in private industry, and a portfolio approximating the aggregate portfolio of all trusteed pension plans in Canada. For common stocks, a second or "pessimistic" simulation is conducted which embodies the less favourable risk-return characteristics of the subperiod 1967-1980. Detailed notes regarding all assumptions are contained in the table.

Although the table is self-explanatory, a number of observations merit emphasis. As noted, a portfolio made up exclusively of bills constitutes the minimum variance portfolio in the assumed absence of short selling. The narrow range in income replacement rates, from 8.2 percent to 10.7 percent of pre-retirement earnings, together with the low median replacement rate of 9.2 percent, thus illustrate how the risk-return characteristics of bills as a one-period investment translate into analogous characteristics regarding income replacement rates. (Remember that the annuities are purchased at a 2.5 percent interest rate, which is roughly consistent with the pension benefits being preserved in real terms. This fact is crucial

in interpreting all of the calculated replacement rates.) For stocks, based on the historical simulation, the median replacement rate of 37.0 percent is much higher, as is the range of 11.6 to 161.4 percent. Indeed, the reported ranges do not overlap, suggesting that common stocks dominate bills as a long-term investment. Although, this observation merits qualification since a larger number of trials would eventually produce an overlap in these ranges, the basic point remains. If historical data are an adequate guide to future performance, stocks would appear to dominate bills as a long run nvestment. The substantial variance in one-period returns also suggests that there would be substantial uncertainty regarding the income that would ultimately be replaced if all funds in the money purchase plan were invested in common stocks. Even in the "pessimistic" simulation, common stocks promote a much higher median replacement rate, with little likelihood that the worst outcome for stocks will be significantly lower than the worst outcome for bills. The above contrast merits increased emphasis when it is recognized that deposits at financial intermediaries - which are held in many RRSPs - have a lower expected return than do Treasury Bills.[12]

Consider, finally, the replacement rates under the two diversified portfolios which are broadly representative of trusted pension plans. The median replacement rates are much higher than for the bills only portfolio, although the uncertainty regarding these replacement rates is also higher. Again, the results are best viewed as depicting the translation of traditional risk-return trade-offs on one-period rates of return into analogous risk-return trade-offs for terminal wealth and - ultimately - for the pensions

---

[12] During the period 1978-1980, for example, the rate on non-chequable deposits at the chartered banks averaged about 150 basis points (i.e. 1.5 percent) less than the return on 91-day bills. Rates on non-chequable deposits at trust companies may average 25 to 50 basis points higher than rates paid by the chartered banks. The non-chequable deposit and bill rates do move in tandem, however, indicating that the variances in the returns so produced are approximately equal.

purchased by the accumulated wealth.

The simulations reported in Table 3 illustrate the impact of the length of the contribution period (i.e. the number of years in which the worker - or the employer on the worker's behalf - contributes to the money purchase plan) on the income replacement rates for the portfolios examined in Table 2. The major point to note is that the dominance of risky assets (stocks) over less risky assets (bills) is less clear, the shorter is the contribution period. For the 15-year contribution period, the worst outcome for stocks is inferior to the worst outcome for bills, unlike the 45-year period examined in Table 2. Since these results are self-explanatory, no further treatment is accorded them in the text. These results do, however, provide a useful background against which to raise the question of the sensitivity of the bill results to the assumption that bill returns are not serially correlated. When the serial correlation noted in footnote 10 is built into the simulation exercises,[13] the degree of uncertainty regarding the income replacement rate increases. This result, which is expected (footnote 11), can be seen by comparing the revised results for 15-year and 45-year contribution periods to those reported in Table 3. For the 45-year period, the range of replacement rates is now 4.3 to 19.1 percent, which is considerably greater than the previous range of 8.2 to 10.7 percent. For the 15-year period, the range is now 2.4 to 5.9 percent, rather than 3.3 to 4.0 percent. The median replacement rates for the 15-year and 45-year contribution periods are 3.4 and 8.6 percent in the "serial correlation" simulation, or slightly less than in the previous simulations. In short, the simulations reported in Table 3 are likely to <u>understate</u> the degree of

[13] The equation reported in footnote 10, together with the initial condition that the bill rate is at its historical mean of 82 basis points, is used to generate the stochastic returns on bills in this additional simulation.

uncertaintyin the income replaced through a bills only portfolio because they ignore the positive serial correlation in real bill returns. By implication, the attractiveness of a bills only portfolio - or term deposits at trust companies and other similar investments - is overstated.

In Table 4, the sensitivity of the calculated replacement rates to the salary growth assumption is examined. The reported figures assume a zero (real) growth rate in salaries, compared to the 2 percent assumed in the previous tables. The obvious result is that ceteris paribus the higher the (real) growth rate of salary (or the steeper is the age-earnings profile), the lower will be the replacement rate. For bills, for example, the median replacement rate rises from 9.2 to 14.4 percent, or by more than 50 percent. These results reflect the fact that pre-retirement earnings are higher if the assumed growth rate is higher, thus reducing the replacement rate corresponding to any fixed stream of pension payments. Although the 3.5 percent contribution rate is applied to higher lifetime earnings if the salary growth assumption is increased, so that both terminal wealth and the annuities so purchased increase, the annuities do not rise sufficiently to prevent a decline in the ratio of pension income to pre-retirement earnings. Since this result is so clear from comparing the zero growth and 2 percent salary growth cases, there is no reason to refine the illustration by postulating more complicated age-earnings profiles.

In Table 5, the impact of altering the interest rates used to cost (purchase) the annuities is illustrated. Obviously, as the annuity interest rate rises, the replacement rate increases. This result occurs, quite simply, because the size of the annuity that can be purchased for a given capital sum increases as the annuity interest rate rises. A change in the

annuity rate from 2.5 to 7.5 percent, for example, increases the median replacement rate for the bills only portfolio from 9.2 to 13.2 percent, which represents an increase of 50 percent. Mechanically, the impact of altering the annuity rate assumption is quite apparent. The economic implications, including the implicit role of inflation, merit elaboration.

Note first that the minimum variance portfolio is the bills only poltfolio, which would yield an expected real return of slightly less than one percent. A potential retiree who wanted to ensure that the stream of pension payments most closely ressembled a real payments stream would buy a variable annuity,[14] at an interest rate of about one percent, and hold only bills. If an insurance company were willing to assume the (relatively modest) investment risk implied by a bills only portfolio, the insurance company could sell fully indexed (i.e. real) annuities at an interst rate of somewhat less than one percent. From this perspective, the use of a one percent assumption might best approximate the real replacement rate (i.e. the ratio of a real or constant dollar benefit to pre-retirement earnings) that could be obtained under the alternative portfolios. Regardless of the portfolio chosen during the accumulation or contribution period, the plan member would choose to invest the accumulated funds at the date of his retirement in bills only, either directly in the case of a variable annuity or indirectly in the case of an indexed annuity sold by a life insurance company seeking to minimize its own risk exposure. The use of the 2.5 percent annuity rate in the main body of simulation

---

[14] For a discussion of variable annuities, see McGill (1979). Let v be the interest rate used to determine the annuity payments that can be purchased with an initial sum of capital. Then, for each year t, the pension benefit will equal $(1+r_t)/(1+v)$ times the benefit paid in year $t-1$. If the rate of return (r_t) earned in period t exceeds the assumed valuation rate, the benefit is increased and conversely.

experiments thus represents somewhat of a departure from the real replacement rate concept. On the other hand, as illustrated by the Task Force (1980), the use of "excess" investment earnings over (say) 2.5 percent on a portfolio of short-term debt instruments is likely to provide a very high degree of cost-of-living protection.

Consider now the implications of using a somewhat higher annuity rate assumption. For purposes of illustration, assume that a bills only portfolio provides a real return of one percent with certainty. Assume that the anticipated rate of inflation is 6.5 percent, and that - correspondingly - nominal bill yields are 7.5 percent. If this 7.5 percent rate is used to value the annuity, then the pension so acquired is <u>implicitly</u> expected to decline in real terms at a rate of 6.5 percent per year. In this case, the replacement rate so calculated is purely nominal. Its value, in turn, conveys little useful information unless the anticipated rate of inflation is also specified. For higher inflation rates, nominal or market bill yields would be higher. If these higher rates were used to value the annuity in the present example, the calculated replacement rates would rise in tandem with the interest rate assumption - as would the expected rate of decline in the real value of the pension due to inflation. This example illustrates why the use of arbitrarily high interest rates in the annuity calculation is potentially misleading and ultimately not very useful. Because nominal interest rates move in tandem with inflation, and since forecasts of the inflation rate - and hence the level of nominal interest rates - in the <u>distant</u> future are so speculative, their use in annuity calculations has little merit. It is more useful to focus the simulation experiments on real replacement rates, both because (1) plan members are

presumably interested in the real value of their pension benefits and (2) the resulting calculations require no assumption about the (highly uncertain) future rate of inflation.

Analysis of the choice of an annuity rate assumption in the case in which the funds are invested in risky assets is also straightforward. If the funds are invested only in stocks, the expected real return would (approximately) equal 8 percent. The use of this rate to value the annuity would thus be consistent with the claim that the replacement rate so calculated is a real replacement rate (i.e. it is expected that the real value of the benefit will remain constant). If the retiree were to purchase a variable annuity at an interest rate of 8 percent, and to hold only stocks, he would expect the real stream of annuity payments to remain constant. Because of the large variance in stock returns, however, the real income stream would in fact be highly risky, which the plan member may find unattractive. From an alternative perspective, it is quite unlikely that a life insurance company would be willing to underwrite an indexed annuity at 8 percent by investing solely in common stocks. The shareholders of the life insurance company would demand very large compensation for assuming this investment risk. Indeed, if bills did yield a real return of one percent with certainty, the life company would only have to offer a yield of one percent on a fully indexed annuity. If the life company wanted to invest only in stocks, then the difference in the expected real returns of 7 percent (i.e. 8 percent on stocks less one percent on bills) is the market determined compensation that shareholders of the life insurance company would require to compensate them for assuming the investment risk inherent in the stocks only portfolio.

To sum up, it would appear to be appropriate to use an annuity rate assumption of not more than (say) 2.5 percent if the intention is to value a benefit which is both real and relatively certain. A retiring plan member could purchase a variable annuity backed by a risky portfolio in order to earn a higher (expected) real return, but the resulting income stream would be very uncertain.

The major conclusions drawn from the simulation exercises can be succinctly summarized:

(1) For all investment portfolios, including Treasury Bills when their positive serial correlation is acknowledged, there is substantial uncertainty regarding the ratio of pension income to pre-retirement earnings (the "income replacement rate") for a money purchase plan with a fixed contribution rate. This result reflects the fact that the plan member bears all of the investment risk, together with the uncertainty regarding the real returns on alternative plan assets.

(2) The stochastic simulations reported in the text translate the risk-return characteristics of the annual returns on alternative assets/portfolios into risk-return characteristics of the replacement rates of money purchase plans invested in the corresponding assets/portfolios. This information is essential if participants in money purchase plans - including RRSPs - are to make fully informed investment decisions.

(3) For <u>long</u> contribution periods or investment horizons, the attractiveness of common stocks as an investment vehicle merits note. By contrast, Treasury Bills - especially once the serial correlation in bill

returns is acknowledged - appear less attractive. This latter point assumes increased importance when it is recognized that (1) Treasury Bills are likely to dominate (higher expected return with the same variance) deposits at financial intermediaries and (2) such deposits are widely held in RRSPs.

(4) For a given contribution rate (i.e. contribution as a percent of salary), the income replacement rate under a money purchase plan will fall as the age-earnings profile becomes steeper. The income replacement rate will fall, other things equal, as the interest rate used in the annuity calculation increases. This result is likely to reflect different - and implicit - degrees of erosion of the nominal pension benefit by inflation. This result merits more attention than it is customarily given.

(5) The fact that members of money purchase plans bear substantial investment risk, as evidenced by the uncertainty regarding income replacement rates, must be placed in perspective. In particular, the risks to which members of defined benefit plans are exposed, the extent to which investment risk is actually transferred to the employer/shareholders in defined benefit plans, and so forth merit closer study. It should be acknowledged, however, that proponents of money purchase plans may devote too little attention to the issue of investment risk.

V Money Purchase versus Defined Benefit Plans and the Role for Public Policy

Does the fact that members of money purchase plans may be exposed to substantial investment risk suggest that money purchase plans should <u>not</u> be

encouraged as a matter of public policy? To answer this question, one must look at the risks to which the member of a defined benefit plan is exposed. There are at least three issues to be examined. First, to what extent are members of defined benefit plans subject to the principle source of risk in today's economic climate, which is inflation risk? Second, to the extent that investment risk per se is borne by employer/shareholders in defined benefit plans, what wage differentials compensate employers/ shareholders for assuming this risk? Third, to what extent to members of defined benefit plans actually assume investment risk? To the extent, for example, that members of defined benefit plans receive ad hoc cost of living adjustments linked ultimately to the performance of the pension fund, the plan members clearly bear - at least in part - the investment risk. The distinction between defined benefit and money purchase plans thus becomes blurred, and the argument that defined benefit plans ought to be encouraged because they represent the market solution to optimal pension arrangements is clearly weakened. These three issues are analyzed in turn.

1. The Exposure of Members of Defined Benefit Plans to Inflation Risk

Note first that if the defined benefit is nominal (i.e. not indexed), then the plan member is obviously exposed to inflation risk. Formally, the accrued benefit of the plan member is analytically equivalent to a long-term bond. To the extent that investment risk and inflation risk are virtually synonymous for fixed-income securities, the plan member - through the investment characteristics of his accrued benefit - is very exposed to investment risk. (The plan member, it should be noted, may be able to hedge his exposure to inflation risk if (say) he has a home with a large outstanding mortgage.

For purposes of analysis, however, it will be assumed that the exposure of the plan member to inflation risk is undesirable from the viewpoint of the plan member.) The exposure to inflation risk is readily apparent when the defined benefit is nominal, and this point is raised again later in the discussion. What is less apparent, however, is the fact that the member of a defined benefit plan which provides a fully indexed benefit at retirement is still subject to a high degree of inflation risk. This more subtle case is treated at length below.

Consider an extreme final earnings plan in which the benefit is based solely on the worker's salary in his final year of employment and is fully indexed after the worker retires. An analyst might value this plan, for example, by using a 2.5 percent interest rate assumption and by assuming that the worker's (real) salary grows exogenously at 2 percent per year. Obviously, as the example is constructed, the plan member is not exposed to inflation risk. In this regard, however, the example is quite misleading. The example is misleading in its presumption that the worker's salary can be treated as exogenous. Although this assumption may well be appropriate for a defined contribution plan, in which any increase in salary does not increase the value at past service credits, this assumption is not likely to be valid for a defined benefit plan if labour markets are competitive.

In a competitive labour market, a worker receives total compensation in every period exactly equal to the value of his marginal product (i.e. the value to the firm of his labour services). Total compensation equals the current wage plus the change in the accrued value of the worker's pension benefits. Assume that a worker is a member of the defined benefit plan described above, and that inflation of 10 percent took place in the previous

year. An increase in the worker's current wage has two distinct effects: first, it represents an increase in the current wage component of the compensation package' and second, it enhances the value of all past service credits. For a worker with significant past service credits, the latter effect is potentially quite large. The competitive labour market ensures that the worker receives only the value of his marginal product. The fact that an increase in the current wage rate also increases the value of all past service credits is thus factored into the calculation of the competitively determined increase in the wage rate. In the example at hand, there is no reason to expect that in a competitive labour market the employer/shareholders will gratuitously "make up" the erosion by the 10 percent inflation of the real value of past service credits. Until the worker actually reaches retirement age, his accrued benefits remain nominal and thus have the investment characteristics of a long-term bond. The worker thus remains highly exposed to inflation risk. If unanticipated[15] inflation erodes the real value of past service credits, then there will be an unanticipated reduction in the worker's current wage to compensate the employer/shareholders for upgrading (at least in part) the erosion of these accrued pension benefits. Clearly, if there is uncertainty regarding the rate of inflation, the treatment of the salary scale as exogenous in the original illustration is clearly inappropriate. The contrast with a money purchase plan, in which the current increase in salary leaves the value of past service credits unchanged, merits emphasis.

The point of the above illustration is succinctly summarized. Even in a defined benefit plan in which (1) the benefit is based on earnings in

---

[15] If the inflation had been anticipated, it would have been appropriately discounted by both the worker and the firm in setting the worker's compensation in the previous period.

the worker's very last year of employment and (2) the benefit is fully indexed after the worker retires, the worker is still exposed to inflation risk. This result occurs because the accrued benefit, until the worker actually retires, is nominal and thus exposes the worker to substantial inflation risk. If inflation erodes the real value of past service credits, then the worker must compensate the firm for updating the value of these credits. Although there may be some debate among economists about the extent to which the existence of implicit contracts between workers and firms might qualify the above analysis, there is at least one fact that offers considerable support for its basic insight. That is the "paradox" that firms in the private sector are willing to provide final earnings plans, which - crudely - "index" benefits during the pre-retirement period, yet are unwilling to index benefits in the post-retirement period. This "paradox" is easily resolved in the context of the preceding analysis, when it is recognized that the firm can extract current wage concessions in the pre-retirement - but not in the post-retirement - period for enrichments to the value of previously accrued benefits.

As noted at the beginning of the discussion, the pensions provided by defined benefit plans in the private sector typically are not indexed. As a result, the worker's accrued benefit has the investment characteristics of a long-term bond. An unanticipated increase in the inflation rate, if viewed as permanent, will severely depress the "market value" of the pension benefit exactly as it would depress the price of a long-term bond. Note that if a member of a money purchase plan chose to hold only Treasury Bills, his exposure to inflation risk (via its impact on real bill returns) would be far less than the member of the defined benefit plan. This point applies

as well to the terminating (vested) member of a defined benefit plan, whose deferred nominal annuity has the same exposure to inflation risk as a very long-term bond.[16] Indeed, its duration may well exceed that of a consol (i.e. a bond which pays a fixed coupon for perpetuity), so that the percentage change in the value of the worker's accrued benefit may exceed the percentage change in the relevant interest rate.

To sum up, because most defined benefit plans do not provide indexed benefits to terminated (vested) or retired workers, plan members are exposed to substantial inflation risk. Since inflation risk is the prime source of investment risk for fixed-income securities, the implication is that members of defined benefit plans bear risks similar to those borne by members of money purchase plans. Indeed, to the extent that a member of a money purchase plan chooses to hold short-term debt in his portfolio to limit his investment risk, his exposure to inflation risk will be less than that of the member of the defined benefit plan, whose accrued benefits have the investment characteristics of a long-term bond. Finally, when the case of defined benefit plan which provides a fully indexed benefit at retirement is considered in detail, it is clear that the worker is still exposed to substantial inflation risk. This result is due to the fact that at any date prior to retirement, his past service credits still represent a purely nominal pension benefit.

2. The Transfer of Investment Risk to Employers/Shareholders in Defined Benefit Plans and the Role of Compensating Wage Differentials

The principle to be illustrated here can be succinctly stated. To the extent that investment risk in a defined benefit plan is transferred

---

[16] Again, to the extent that inflation has been anticipated, the anticipated erosion of the real value of the deferred annuity will have already been reflected in past compensation awards. It is only unanticipated inflation which is appropriately identified with the inflation risk to which the deferred annuitant is exposed.

from the worker to the firm, shareholders must be compensated for accepting this risk. This simple point, which is discussed below, must be acknowledged in any comparison of defined benefit with money purchase plans.

The point can best be illustrated by reconsidering the case of a benefit that is fully indexed at the time of the worker's retirement. Formal economic analysis indicates that, if this benefit is payable with certainty, it must be valued at the risk-free real rate of interest. Assume, for simplicity, that bills yield a real return of one percent with certainty. Suppose that the sponsor of the defined benefit plan chose to hold a risky pension portfolio, perhaps akin to Fund One (see Table 2). The expected real return on this portfolio (not shown in Table 2) is 3.97 percent. The annuity promised by the plan will be valued by workers at the one percent rate, not the 3.97 percent rate. This is because the interest rate at which workers could purchase fully indexed annuities in the capital market would be only one percent. The difference between the expected real return on the fund and the certain return on the Treasury Bills - equal to 3.97 percent less one percent equals 2.97 percent - is the compensation that shareholders receive for assuming the investment risk. If an observer were to argue that workers, in terms of the implicit return on wages forgone to acquire pension benefits, earned 3.97 percent in the above example, he would clearly be overstating the value to workers of their membership in the defined benefit plan.

If no risk-free real asset exists, the analysis is only slightly more complicated. Assume that workers are risk averse but that employers/ shareholders are risk neutral. If workers want fully indexed pensions, they would value these benefits at (their) certainty equivalent of the risk-free real rate. The difference between the expected return on the pension

portfolio and this certainty equivalent rate is, in effect, the insurance premium paid by workers to relieve them of all investment risk. As a result, however, they earn a very low (and possibly negative) real return on the wages foregone to acquire their pension benefits. Equivalently, because of the very low interest rate used to discount the stream of real pension payments, the concession in current wages that workers must make in order to acquire their pension benefits must be quite large.

In short, employers/shareholders must be compensated for assuming investment risk - to the extent that they do assume investment risk - in defined benefit plans. Although the fact that employers/shareholders may be better suited to assuming investment risk than workers merits notice, and may ultimately provide a rationale (at least in a non-inflationary environment) for defined benefit plans, the role of compensating wage differentials as discussed merits emphasis. To ignore the role of compensating wage differentials is, in a very superficial way, to overstate the value to workers of participating in defined benefit plans.

3. Ad Hoc Cost-of-Living Adjustments Financed from "Excess" Investment Earnings: Are Defined Benefit Plans Just Money Purchase Plans in Disguise?

In spite of the fact that the pensions provided by most defined benefit plans in the private sector are not contractually indexed, many employers have made substantial ad hoc payments to limit the eroding impact of inflation on pensions in pay. There are no official data compiled by the Government of Canada on either the magnitude of frequency of these adjustments. Two private surveys, however, provide evidence on this issue. The Report by Tomenson-Alexander (1978) notes that 117 of the 149 large (active membership

of at least 500) plans surveyed provided some form of cost-of-living adjustments to pensions in pay during the period 1971-1975. For the majority (101 respondents), the adjustments were not required under the terms of the plan and thus were entirely ad hoc. For those plans reporting adjustments, the payments averaged two-thirds of the amount necessary to offset fully the impact of inflation as measured by the consumer price index. The most recent Report on Survey of Pension Plans in Canada (March, 1980) by the Financial Executives Institute Canada (FEIC) indicated that 75 percent of the respondents had taken some action to offset the impact of inflation. Again, in the great majority of cases, this action was taken unilaterally by the plan sponsor.

Of equal importance, there is evidence that a significant proportion of these payments are being financed out of "excess" investment earnings, or investment earnings in excess of the assumed valuation rate. The FEIC reports that 59.5 percent (by plan respondent) of the cost increases were funded out of plan assets, while 31.8 percent were "expensed as paid". It would appear that "expensed as paid" refers to payments out of general corporate revenues, although this is not clear from the questionnaire. In the Tomenson-Alexander survey, the ad hoc adjustments were financed - in whole or in part - through general corporate revenues for only 32 of the 117 firms which made these adjustments. The majority of firms thus financed the ad hoc payments by creating new unfunded liabilities which were discharged through a combination of plan surpluses and special payments. In general, the likelihood that many firms are using "excess" investment earnings to finance ad hoc cost-of-living adjustments and/or nominal benefit enrichments (career average plan) is widely acknowledged within the private pension

industry. At the National Pensions Conference held 31 March to 2 April (1981) in Ottawa, discussions of ways to improve the cost-of-living protection afforded pension benefits focused on the use of "excess" investment earnings. The apparent support among employers' delegates for this principle provides de facto evidence that this is already a widespread practice.

To the extent that ad hoc cost-of-living adjustments are linked, at all or in part, to the performance of the pension fund, workers in fact bear the brunt[17] of investment risk in these defined benefit plans. This point has two important implications. First, and perhaps as a response to increased inflation uncertainty, defined benefit plans have taken on the fundamental characteristic of money purchase plans. Second, the argument the defined benefit plans represent the market solution to private pension arrangements loses much of its force. Indeed, to the extent that there are legal or institutional (for example, the existence of large unfunded liabilities) impediments to the termination of defined benefit plans and their replacement by money purchase plans, the metamorphosis of defined benefit plans described above may be interpreted as implying that money purchase plans are now the market's preferred solution.

VI Implications for Public Policy

The major policy implications of this study are reviewed briefly below.

---

[17] Because benefits which are enriched in nominal terms tend not to be reduced (in nominal terms), the sponsor in fact places a succession of nominal floors on the pension benefit. If investment earnings are below the assumed valuation rate, the plan sponsor makes up the shortfall. In this sense, the plan sponsor and the worker share the investment risk. Formally, the worker has a nominal benefit that is guaranteed by the plan sponsor and a call option on investment earnings with a striking price equal to the valuation interest rate.

1. Participants in money purchase plans, including RRSPs, bear all of the investment risk associated with saving and accumulating capital for retirement. They should be informed of the uncertainty regarding the income that would ultimately be replaced through a money purchase plan, with a fixed contribution rate, together with the relationship between this uncertainty and the risk-return characteristics of alternative assets. To advocate the expansion of money purchase plans without an explicit assessment of this issue would be irresponsible.

2. The fact that members of money purchase plans bear all of the investment risk does not constitute a de facto argument in favour of defined benefit plans. Even if the pension provided by a defined benefit plan is fully indexed at retirement, the plan member's accrued benefit is purely nominal until he reaches retirement age. The accrued benefit is equivalent to a long-term bond, and the plan member is thus exposed to considerable inflation risk. In the more realistic case where the benefit is not indexed, the accrued benefit remains nominal - and thus retains the investment characteristics of a long-term bond - after the plan member retires. Because their (nominal) accrued benefits are so vulnerable to inflation risk, members of defined benefit plans are clearly more subject to the risks posed by unanticipated changes in the rate of inflation than are members of money purchase plans if the latter choose to hold less risky (than long-term bonds) assets such as (say) shorter term fixed-income securities.

In certain instances, firms who sponsor defined benefit plans may assume a significant amount of investment risk. This is perhaps

most apparent if the benefit is fully indexed at retirement. What merits emphasis in this case, however, is that the firm's shareholders must be compensated for accepting this risk. If the benefit is fully indexed, for example, then it must be valued for purposes of current versus deferred wage trade-offs at the risk-free real rate of interest.[18] Any expected return on the pension fund's assets in excess of this rate (which is clearly less than the one percent expected real return on Treasury Bills) represents compensation to the shareholders for assuming the attendant investment risk. Without due consideration of the fact that shareholders must be compensated if - in fact - investment risk is transferred to them, the advantage to plan members of any reduction in risk that occurs by virtue of their participation in a defined benefit plan is easily overstated.

3. The most crucial evidence regarding the market's acceptance of the money purchase concept is the apparent metamorphosis of many defined benefit plans into defined benefit/money purchase hybrids. There is substantial evidence that many (and perhaps most) sponsors of defined benefit plans have been making ad hoc cost-of-living adjustments to pensions in pay if investments earnings exceed the assumed valuation rate and the plan thus experiences an actuarial surplus. In short, workers - not the employer/shareholders - assume most of the investment risk on the plan's funds. For those plan sponsors who make no such adjustments, members are - of course - exposed to substantial inflation risk. The metamorphosis of defined benefit plans as

---

[18] This assumes that the indexed benefit is payable with certainty. Note that the result obtains regardless of the interest rate used by the firm to value the benefits payable under the terms of the plan. The valuation assumption, in this instance, is appropriately regarded as an accounting "veil".

described above nullifies to a large extent the argument that they represent the market's preferred solution to the optional pension arrangement. Although a detailed assessment of why defined benefit plans were introduced on such a large scale lies beyond the scope of the present report, it would appear that any explanation that focuses on the transfer of investment risk from plan members to shareholders does not withstand close scrutiny.[19]

4. Even if a universal money purchase plan (such a PURS) is not mandated into existence, money purchase plans will likely play an increasingly important role in Canada's retirement income system. Note only do RRSPs continue to grow, but the likelihood is that a "locked-in" RRSP will play a major role in reforms designed to increase the effective portability of pension benefits. In view of this fact, the following are of continued importance.

   (i) Participants in money purchase plans must be made aware of the risk-return characteristics of alternative assets, especially as they pertain to the income replacement objective of retirement planning. Stochastic simulations of the type performed in this study should be of particular value in this regard. The role for public policy is to encourage the dissemination of this information.

   (ii) During a plan member's work years, he may have the flexibility to vary his contribution rate - by altering his work-leisure and/or consumption-savings behaviour - as a means of enhancing

[19] In addition to any incentive-oriented dimensions of defined benefit plans, one might speculate that their original appeal stems - at least in part - from the fact that the more rapid accrual of benefits as the worker ages mirrors the worker's desire to receive a larger fraction of his total compensation in this tax-sheltered form as he ages and thus approaches retirement.

his ability to assume investment risk. This fact, together with the relatively long investment horizon, increases the likelihood that a well-informed plan member might choose a risky portfolio during his active work years, and a less risky portfolio - such as a variable annuity tied to a bills only portfolio - in his retirement years. This possibility, together with the prospects for new annuity design in an inflationary climate, merit continued attention.

(iii) Particularly when explicit consideration is given to the fact that their returns are likely to be serially correlated, relatively "safe" assets such as Treasury Bills - as well as the fixed-term deposits at financial intermediaries which they dominate - may not prove to be an attractive asset for individuals with a <u>long</u> investment horizon. This possibility, and the broader issue of informing plan members of risk return tradeoffs in the context of the income replacement objective of retirement planning, merit increased attention.

REFERENCES

Fama, E.F. (1976), Foundations of Finance (New York: Basic Books).

Financial Executitives Institute Canada (1980), Report on Survey of Pension Plans in Canada (Toronto: Financial Executives Institute Canada).

McGill, Dan, M. (1979), Fundamentals of Private Pensions (Homewood, Illinois: Richard D. Irwin, Inc. for the Pension Research Council).

Royal Commission on the Status of Pensions in Ontario (1981), Report (Toronto: Government of Ontario).

Sanderson, A.R. (1980), DRI Readings in Macroeconomics (New York: McGraw-Hill).

Task Force on Retirement Income Policy (1980), The Retirement Income System in Canada: Problems and Alternative Policies for Reform (Hull, Quebec: Government of Canada).

Tomenson-Alexander Associates Ltd. (1978), Report on Certain Aspects of the Public Service Employee Pension Program (Ottawa: Treasury Board, Government of Canada).

Table 1

REAL RATES OF RETURN (PERCENT PER YEAR) ON ALTERNATIVE ASSETS: 1953 - 1980

Year	(1) 91-day Treasury Bills	(2) Long-term Canada Bonds	(3) Common Stocks	(4) Provincial Bonds	(5) Corporate Bonds	(6) Conventional Mortgages	Inflation (C.P.I.)
1953	1.71	3.61	2.72	5.12	3.84	4.76	0.0
1954	0.83	9.20	38.46	23.74	9.66	5.82	0.60
1955	1.32	-0.61	17.32	-2.87	1.89	5.85	0.30
1956	-0.17	-6.45	8.90	-12.50	-10.49	0.45	3.10
1957	1.58	4.08	-22.37	7.71	4.98	3.41	2.15
1958	-0.26	-8.17	28.16	-3.84	0.51	4.82	2.52
1959	3.39	-5.84	3.04	-6.32	-5.61	3.86	1.37
1960	1.83	5.56	0.33	9.36	10.36	6.66	1.35
1961	2.68	9.48	32.41	9.05	8.55	6.86	0.13
1962	2.42	1.42	-8.70	2.85	3.14	5.33	1.59
1963	1.70	2.66	13.50	2.58	3.38	5.08	1.83
1964	1.79	4.48	22.96	4.82	2.54	4.97	1.93
1965	1.05	-1.87	3.57	-2.59	-3.39	2.68	2.90
1966	1.39	-1.92	-10.28	-4.79	-5.03	1.96	3.55
1967	0.48	-5.99	13.32	-3.68	-4.26	1.86	4.14
1968	2.09	-4.37	17.53	-2.48	-1.75	2.46	4.09
1969	2.50	-6.47	-5.29	-7.06	-5.46	0.12	4.58
1970	4.46	19.67	-5.01	15.93	11.63	9.96	1.46
1971	-1.41	5.98	2.84	7.47	8.65	8.14	5.04
1972	-1.46	-3.76	21.14	1.13	3.77	3.44	5.09
1973	-3.34	-6.78	-8.70	-7.41	-6.12	-2.23	9.12
1974	-4.13	-12.48	-34.76	-13.40	-16.28	-7.20	12.46
1975	-1.91	-6.09	9.31	-2.18	-1.21	2.16	9.48
1976	2.88	11.99	4.82	13.25	14.37	7.54	5.82
1977	-1.98	-3.32	0.43	-0.86	1.20	4.32	9.50
1978	0.23	-6.56	19.25	-4.14	-3.38	-1.64	8.43
1979	1.76	-11.14	31.64	10.47	-10.65	-3.87	9.76
1980	1.42	-8.22	16.83	-7.45	-8.29	-2.99	11.21
Mean	0.82	-0.78	7.97	-0.01	0.23	3.02	4.41
Standard Deviation	2.02	7.60	17.02	7.89	7.46	3.93	3.67

... 2

Table 1 continued

Correlation Coefficients

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
(1) Bills	—	.526	.216	.440	.402	.486	-.623
(2) Canada's		—	.048	.946	.893	.836	-.599
(3) Stocks			—	.115	.202	.212	-.226
(4) Provincials				—	.964	.840	-.542
(5) Corporates					—	.902	-.565
(6) Mortgages						—	-.740
(7) Inflation							—

Notes: Data are drawn from C.G. Carlton, D.D. Ezra and K.P. Sharp, "Canadian Investment Returns and Other Economic Statistics, 1926-1980", where details regarding the calculation of the individual series may be found. For purposes of calculating the nominal returns, mortgages are treated as 5-year bonds. The annual return on Treasury Bills is obtained by the successive purchase of 91-day Treasury Bills at the end of each quarter. No default experience is reflected in the corporate bond and residential mortgage returns, so that these returns represent upper bounds relative to those on default-free Treasury Bills and long-term Canada bonds.

Table 2

INCOME REPLACEMENT RATES UNDER ALTERNATIVE INVESTMENT STRATEGIES: SIMULATION RESULTS (25 TRIALS)

Replacement Rate (3.5% Contribution Rate)[a]	Investment Portfolio				
	Common Stocks				
	Historical[b]	Pessimistic[c]	Treasury Bills	Fund One[d]	Fund Two[e]
median (%)	37.0	21.9	9.2	17.8	16.4
range	11.6 to 161.4	7.5 to 90.2	8.2 to 10.7	11.5 to 30.5	10.9 to 27.2
3rd highest	114.9	65.7	10.3	26.8	24.0
3rd lowest	13.5	8.9	8.3	12.2	11.5

[a] If the contribution rate were 1.0% of salary, then each replacement rate would equal 1.0 ÷ 3.5 or .2857 times the replacement rate reported above.

[b] Historical simulation assumes mean (real) return of 7.97% per annum and a standard deviation of 17.02% per annum, based on the sample period 1953-1980.

[c] Pessimistic simulation assumes mean (real) return of 5.95% per annum and a standard deviation of 16.51% per annum, based on the subperiod 1967-1980.

[d] Fund One is a proxy for the aggregate portfolio of trusteed pension plans in private industry as of 31 December, 1979. Fund One consists of common stocks (29.0%), mortgages (16.1%), Government of Canada bonds (12.9%); provincial-municipal bonds (9.6%), corporate bonds (17.4%), and liquid assets/Treasury Bills (15.0%).

[e] Fund Two is a proxy for the aggregate portfolio of all trusteed pension plans in Canada as of 31, December, 1979. Fund Two consists of common stocks (20.6%), mortgages (13.8%), Government of Canada bonds (9.9%), provincial-municipal bonds (31.1%), corporate bonds (13.4%), and liquid assets/Treasury Bills (11.2%).

Assumptions: Real salary growth is 2% per year; contributions are made from age 20 to age 64 (45 years); life expectancy is 16 years at retirement; annuity is purchased at an interest rate of 2.5%. Means, variances and correlation coefficients are those reported in Table 1, except that the means of the Canada, the provincial and the corporate bonds have been raised by 278, 276 and 277 basis points to equal 2.0%, 2.75%, and 3.0% respectively.

Table 3

INCOME REPLACEMENT RATES: ALTERNATIVE CONTRIBUTION PERIODS

Replacement Rate (3.5% Contribution Rate)	Investment Portfolio				
	Common Stocks				
	Historical	Pessimistic	Treasury Bills	Fund One	Fund Two
45 YEARS					
median (%)	37.0	21.9	9.2	17.8	16.4
range	11.6 to 161.4	7.5 to 90.2	8.2 to 10.7	11.5 to 30.5	10.9 to 27.2
3rd highest	114.9	65.7	10.3	26.8	24.0
3rd lowest	13.5	8.9	8.3	12.2	11.5
35 YEARS					
median (%)	21.9	14.7	7.5	12.5	11.7
range	7.9 to 65.7	5.6 to 43.7	6.7 to 8.6	8.5 to 19.5	8.2 to 17.9
3rd highest	45.5	30.7	8.3	17.3	16.0
3rd lowest	9.8	7.3	7.0	9.4	9.0
25 YEARS					
median (%)	11.3	8.7	5.7	8.1	7.7
range	4.3 to 20.4	3.5 to 15.5	5.1 to 6.1	5.5 to 10.2	5.4 to 9.7
3rd highest	17.3	12.5	5.9	9.3	8.9
3rd lowest	6.1	4.8	5.3	6.3	6.1
15 YEARS					
median (%)	5.3	4.6	3.6	4.5	4.3
range	2.7 to 12.9	2.4 to 10.6	3.3 to 4.0	3.4 to 6.2	3.4 to 5.9
3rd highest	7.4	6.3	3.8	5.0	4.9
3rd lowest	2.9	2.5	3.4	3.6	3.7

Assumptions and Notes: See Table 2.

Table 4

INCOME REPLACEMENT RATES UNDER ALTERNATIVE INVESTMENT STRATEGIES: NO SALARY GROWTH

Replacement Rate (3.5% Contribution Rate)	Investment Portfolio				
	Common Stocks				
	Historical	Pessimistic	Treasury Bills	Fund One	Fund Two
median	67.3	38.4	14.4	30.4	27.8
range	20.1 to 304.8	12.1 to 164.9	12.6 to 16.9	19.2 to 53.8	18.0 to 47.5
3rd highest	213.7	117.8	16.3	47.5	42.1
3rd lowest	23.1	14.1	12.8	19.8	18.6

Assumptions and Notes: See Table 2 (except for real salary growth).

Table 5

INCOME REPLACEMENT RATES WITH NOMINAL INTEREST RATE IN ANNUITY CALCULATION

	Median Replacement Rate				
	Common Stocks				
Annuity Interest Rate (%)	Historical	Pessimistic	Treasury Bills	Fund One	Fund Two
1.0	32.8	19.4	8.2	15.8	14.6
2.5	37.0	21.9	9.2	17.8	16.4
5.0	44.5	31.0	11.2	21.5	19.9
7.5	52.8	31.2	13.2	25.9	23.5
10.0	61.7	36.5	15.4	29.7	27.4
12.5	71.1	42.1	17.8	34.3	31.7

Assumptions and Notes: See Table 2 (except for annuity interest rates).

POOR

QUALITY

ORIGINAL